

FCC PART 15.247

TEST REPORT

For

**invoxia**

2 rue Maurice Hartman, Issy-Les-Moulineaux, France

**FCC ID: ZVS-LWT1**

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## **TABLE OF CONTENTS**

<b>GENERAL INFORMATION.....</b>	<b>4</b>
PRODUCT DESCRIPTION FOR EQUIPMENT UNDER TEST (EUT) .....	4
OBJECTIVE .....	4
RELATED SUBMITTAL(S)/GRANT(S).....	4
TEST METHODOLOGY .....	4
MEASUREMENT UNCERTAINTY .....	5
TEST FACILITY .....	5
<b>SYSTEM TEST CONFIGURATION.....</b>	<b>6</b>
DESCRIPTION OF TEST CONFIGURATION .....	6
EQUIPMENT MODIFICATIONS .....	6
EUT EXERCISE SOFTWARE .....	6
DUTY CYCLE .....	7
SUPPORT EQUIPMENT LIST AND DETAILS .....	8
EXTERNAL I/O CABLE.....	8
BLOCK DIAGRAM OF TEST SETUP .....	8
<b>SUMMARY OF TEST RESULTS .....</b>	<b>9</b>
<b>TEST EQUIPMENT LIST .....</b>	<b>10</b>
<b>FCC§15.247 (i), §1.1307 (b) (1) &amp; §2.1093 – RF EXPOSURE .....</b>	<b>11</b>
APPLICABLE STANDARD .....	11
<b>FCC §15.203 - ANTENNA REQUIREMENT.....</b>	<b>12</b>
APPLICABLE STANDARD .....	12
ANTENNA CONNECTOR CONSTRUCTION .....	12
<b>FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS .....</b>	<b>13</b>
APPLICABLE STANDARD .....	13
EUT SETUP.....	13
EMI TEST RECEIVER SETUP.....	13
TEST PROCEDURE .....	13
CORRECTED FACTOR & MARGIN CALCULATION .....	14
TEST RESULTS SUMMARY .....	14
TEST DATA .....	14
<b>FCC §15.209, §15.205 &amp; §15.247(d) - SPURIOUS EMISSIONS.....</b>	<b>17</b>
APPLICABLE STANDARD .....	17
EUT SETUP .....	17
EMI TEST RECEIVER & SPECTRUM ANALYZER SETUP .....	18
TEST PROCEDURE .....	18
CORRECTED AMPLITUDE & MARGIN CALCULATION .....	18
TEST RESULTS SUMMARY .....	18
TEST DATA .....	19
<b>FCC §15.247(a) (2) – 6 dB EMISSION BANDWIDTH.....</b>	<b>25</b>
APPLICABLE STANDARD .....	25
TEST PROCEDURE .....	25
TEST DATA .....	25

<b>FCC §15.247(b) (3) - MAXIMUM CONDUCTED OUTPUT POWER.....</b>	<b>28</b>
APPLICABLE STANDARD .....	28
TEST PROCEDURE .....	28
TEST DATA .....	28
<b>FCC §15.247(d) – 100 kHz BANDWIDTH OF FREQUENCY BAND EDGE.....</b>	<b>29</b>
APPLICABLE STANDARD .....	29
TEST PROCEDURE .....	29
TEST DATA .....	29
<b>FCC §15.247(e) - POWER SPECTRAL DENSITY .....</b>	<b>31</b>
APPLICABLE STANDARD .....	31
TEST PROCEDURE .....	31
TEST DATA .....	31

## GENERAL INFORMATION

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### Product Description for Equipment under Test (EUT)

The *invoxia*'s product, model number: *LWT1* (FCC ID: *ZVS-LWT1*) or the "EUT" in this report was a *LWT* with *Wi-Fi*, *BLE*, *GPS* and *LoRa* function, which was measured approximately: 11 cm (L) × 2.8 cm (W) × 0.9 cm (H), rated with input voltage: DC 3.7V from battery.

*\*All measurement and test data in this report was gathered from production sample serial number: 1701906 (Assigned by applicant). The EUT supplied by the applicant was received on 2017-07-11.*

### Objective

This report is prepared on behalf of *invoxia* in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commission's rules.

The tests were performed in order to determine compliance with FCC Part 15, Subpart C, and section 15.203, 15.205, 15.207, 15.209 and 15.247 rules.

### Related Submittal(s)/Grant(s)

FCC Part 15.249 DXX submissions with FCC ID: ZVS-LWT1.

### Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

All emissions measurement was performed at Bay Area Compliance Laboratories Corp. (Shenzhen). The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

**Measurement Uncertainty**

Parameter	uncertainty
Occupied Channel Bandwidth	±5%
RF Output Power with Power meter	±0.5dB
RF conducted test with spectrum	±1.5dB
AC Power Lines Conducted Emissions	±1.95dB
All emissions, radiated	±4.88dB
Temperature	±3 °C
Humidity	±6%
Supply voltages	±0.4%

**Test Facility**

The Test site used by Bay Area Compliance Laboratories Corp. (Shenzhen) to collect test data is located on the 6/F., West Wing, Third Phase of Wanli Industrial Building, Shihua Road, Futian Free Trade Zone, Shenzhen, Guangdong, China.

The test site has been approved by the FCC under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No.: 382179, the FCC Designation No.: CN5001.

The test site has been registered with ISED Canada under ISED Canada Registration Number 3062B.

## SYSTEM TEST CONFIGURATION

### Description of Test Configuration

For BLE mode, 40 channels are provided to testing:

Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	2402	20	2442
1	2404	21	2444
2	2406	22	2446
3	2408	23	2448
4	2410	24	2450
5	2412	25	2452
6	2414	26	2454
7	2416	27	2456
8	2418	28	2458
9	2420	29	2460
10	2422	30	2462
11	2424	31	2464
12	2426	32	2466
13	2428	33	2468
14	2430	34	2470
15	2432	35	2472
16	2434	36	2474
17	2436	37	2476
18	2438	38	2478
19	2440	39	2480

EUT was tested with Channel 0, 20 and 39.

### Equipment Modifications

No modification was made to the EUT tested.

### EUT Exercise Software

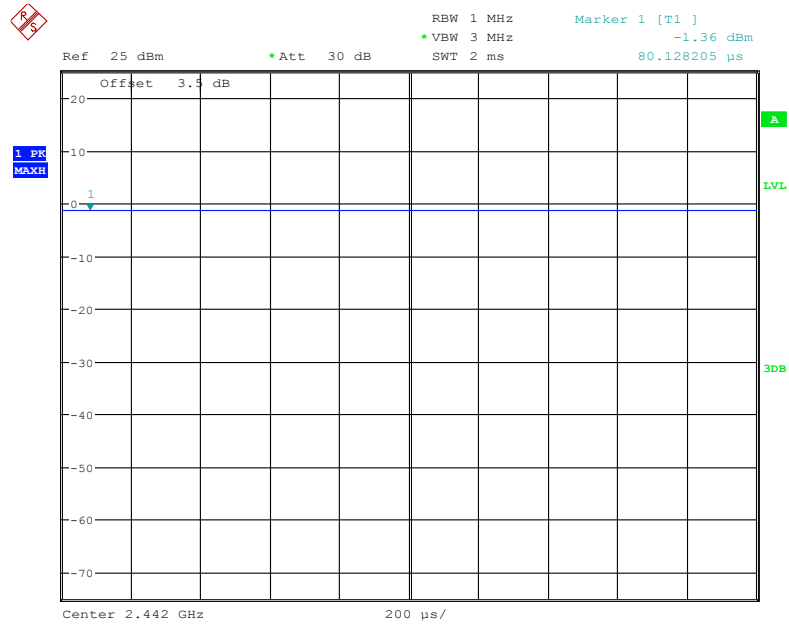
BLE test in the engineer mode.

The device was tested with 100% duty cycle and the worst case was performed as below:

Mode	Data rate	Power level		
		Low channel	Middle channel	High channel
BLE	/	Default	Default	Default

## Duty cycle

## BLE Mode



Date: 21.JUL.2017 10:31:15

Band	Duty Cycle (%)	T(us)	1/T(kHz)	VBW Setting	10log(1/x)
BLE	100	-	-	10Hz	-

Support Equipment List and Details

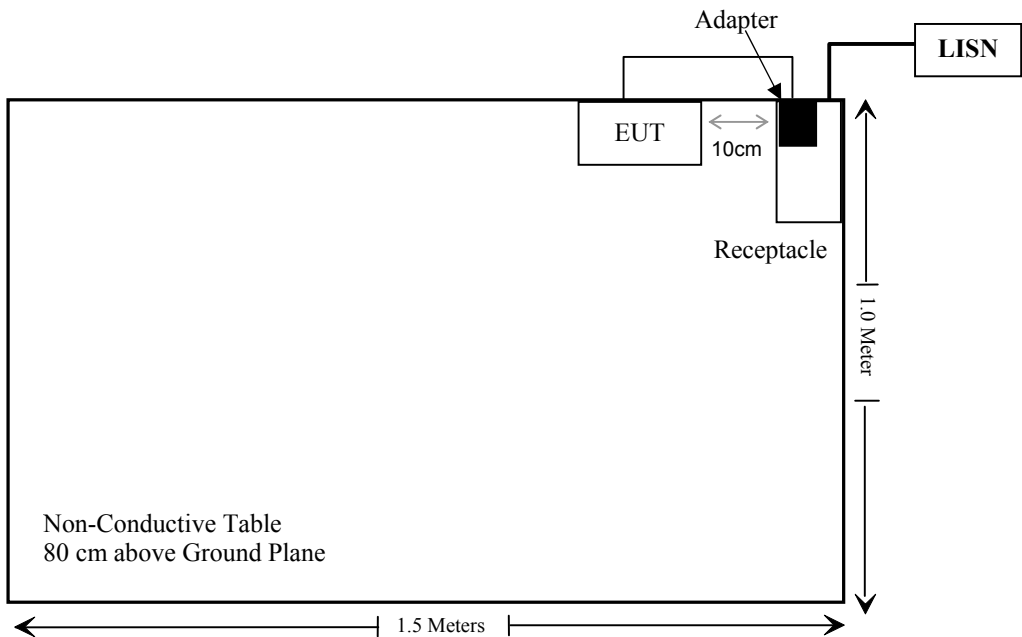
Manufacturer	Description	Model	Serial Number
SUMSUNG	Adapter	ETA0U80EBE	SC1C314FS/A-E

External I/O Cable

Cable Description	Length (m)	From Port	To
Un-shielding Un-detachable USB Cable	0.1	EUT	Adapter

Block Diagram of Test Setup

For conducted emission





**SUMMARY OF TEST RESULTS**

FCC Rules	Description of Test	Result
§15.247 (i), §1.1307 (b) (1)& §2.1093	RF Exposure	Compliance
§15.203	Antenna Requirement	Compliance
§15.207 (a)	AC Line Conducted Emissions	Compliance
§15.205, §15.209, §15.247(d)	Spurious Emissions	Compliance
§15.247 (a)(2)	6 dB Emission Bandwidth	Compliance
§15.247(b)(3)	Maximum Conducted Output Power	Compliance
§15.247(d)	100 kHz Bandwidth of Frequency Band Edge	Compliance
§15.247(e)	Power Spectral Density	Compliance

**TEST EQUIPMENT LIST**

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
<b>Conducted Emissions Test</b>					
Rohde & Schwarz	EMI Test Receiver	ESCS30	100176	2016-10-19	2017-10-19
Rohde & Schwarz	LISN	ENV216	3560.6650.12-101613-Yb	2016-12-07	2017-12-07
Rohde & Schwarz	Transient Limiter	ESH3Z2	DE25985	2017-05-21	2017-11-19
Rohde & Schwarz	CE Test software	EMC 32	V8.53.0	NCR	NCR
N/A	Conducted Emission Cable	N/A	UF A210B-1-0720-504504	2017-05-12	2017-11-12
<b>Radiated Emission Test</b>					
Sunol Sciences	Horn Antenna	DRH-118	A052604	2014-12-29	2017-12-28
Rohde & Schwarz	Signal Analyzer	FSIQ26	8386001028	2017-04-24	2018-04-24
Sunol Sciences	Bi-log Antenna	JB1	A040904-2	2014-12-17	2017-12-16
Mini	Pre-amplifier	ZVA-183-S+	5969001149	2017-02-14	2018-02-14
HP	Amplifier	HP8447E	1937A01046	2017-05-21	2017-11-19
Rohde & Schwarz	EMI Test Receiver	ESCI	101120	2016-12-07	2017-12-07
Ducommun technologies	RF Cable	UFA210A-1-4724-30050U	MFR64369223410-001	2017-05-21	2017-11-19
Ducommun technologies	RF Cable	104PEA	218124002	2017-05-21	2017-11-19
Ducommun technologies	RF Cable	RG-214	1	2017-05-21	2017-11-19
Ducommun technologies	RF Cable	RG-214	2	2017-05-22	2017-11-22
Sinoscite	Band Reject Filter	BSF2402-2480MN-0898-001	N/A	2017-05-21	2018-05-21
<b>RF Conducted Test</b>					
Agilent	P-Series Power Meter	N1912A	MY5000448	2016-12-05	2017-12-05
Agilent	Wideband Power Sensor	N1921A	MY54210016	2016-12-05	2017-12-05
WEINSCHL	3dB Attenuator	N/A	N/A	2017-05-23	2017-11-22
Rohde & Schwarz	SPECTRUM ANALYZER	FSU26	200120	2016-12-05	2017-12-05
Ducommun technologies	RF Cable	RG-214	3	2017-05-22	2017-11-22

\* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Shenzhen) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

## **FCC§15.247 (i), §1.1307 (b) (1) & §2.1093 – RF EXPOSURE**

### **Applicable Standard**

According to FCC §2.1093 and §1.1307(b) (1), systems operating under the provisions of this section shall be operated in a manner that ensure that the public is not exposed to radio frequency energy level in excess of the Commission's guideline.

According to KDB 447498 D01 General RF Exposure Guidance

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances  $\leq 50$  mm are determined by:

$[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0$  for 1-g SAR and  $\leq 7.5$  for 10-g extremity SAR, where

1.  $f(\text{GHz})$  is the RF channel transmit frequency in GHz.
2. Power and distance are rounded to the nearest mW and mm before calculation.
3. The result is rounded to one decimal place for comparison.
4. When the minimum test separation distance is  $< 5$  mm, a distance of 5 mm is applied to determine SAR test Exclusion.

### **Measurement Result**

**For worst case:**

Mode	Frequency (MHz)	Max Tune-up Conducted Power (dBm)	Max Tune-up Conducted Power (mW)	Calculated Distance (mm)	Calculated value	Threshold (1-g SAR)	SAR Test Exclusion
BLE	2480	0	1	5	0.3	3.0	Yes

**Result: No SAR test is required**

**FCC §15.203 - ANTENNA REQUIREMENT**

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**Applicable Standard**

According to § 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the user of a standard antenna jack or electrical connector is prohibited. The structure and application of the EUT were analyzed to determine compliance with section §15.203 of the rules. §15.203 state that the subject device must meet the following criteria:

- a. Antenna must be permanently attached to the unit.
- b. Antenna must use a unique type of connector to attach to the EUT.

Unit must be professionally installed, and installer shall be responsible for verifying that the correct antenna is employed with the unit.

And according to FCC 47 CFR section 15.247 (b), if the transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

**Antenna Connector Construction**

The EUT has a chip antenna, which was permanently attached and the antenna gain is 2 dBi, fulfill the requirement of this section. Please refer to the EUT photos.

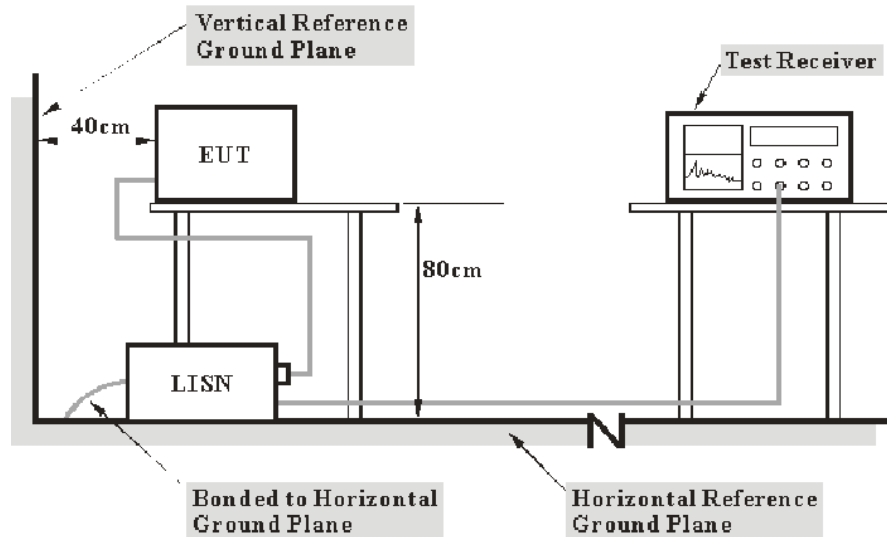
**Result:** Compliance.

## FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS

### Applicable Standard

FCC§15.207

### EUT Setup



Note: 1. Support units were connected to second LISN.  
2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

The setup of EUT is according with per ANSI C63.10-2013 measurement procedure. The specification used was with the FCC Part 15.207 limits.

The spacing between the peripherals was 10 cm.

### EMI Test Receiver Setup

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30 MHz.

During the conducted emission test, the EMI test receiver was set with the following configurations:

Frequency Range	IF B/W
150 kHz – 30 MHz	9 kHz

### Test Procedure

During the conducted emission test, the adapter was connected to the outlet of the LISN.

Maximizing procedure was performed on the six (6) highest emissions of the EUT.

All final data was recorded in the Quasi-peak and average detection mode.

## Corrected Factor & Margin Calculation

The Corrected factor is calculated by adding LISN VDF (Voltage Division Factor), Cable Loss and Transient Limiter Attenuation. The basic equation is as follows:

$$\text{Correction Factor} = \text{LISN VDF} + \text{Cable Loss} + \text{Transient Limiter Attenuation}$$

The “**Margin**” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of 7 dB means the emission is 7 dB below the limit. The equation for margin calculation is as follows:

$$\text{Margin} = \text{Limit} - \text{Corrected Amplitude}$$

## Test Results Summary

According to the recorded data in following table, the EUT complied with the FCC Part 15.207,

Refer to CISPR16-4-2:2011 and CISPR 16-4-1:2009, the measured level complies with the limit if

$$L_m + U_{(L_m)} \leq L_{\text{lim}} + U_{\text{cispr}}$$

In BACL,  $U_{(L_m)}$  is less than  $U_{\text{cispr}}$ , if  $L_m$  is less than  $L_{\text{lim}}$ , it implies that the EUT complies with the limit.

## Test Data

### Environmental Conditions

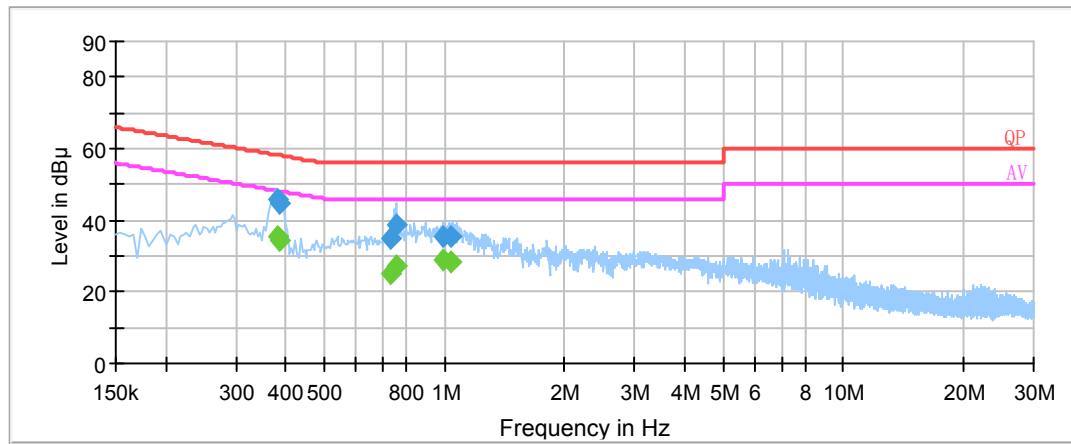
Temperature:	26 °C
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

*The testing was performed by Kobe Li on 2017-07-24.*

*EUT operation mode: Transmitting*

**AC 120V/60 Hz, Line**

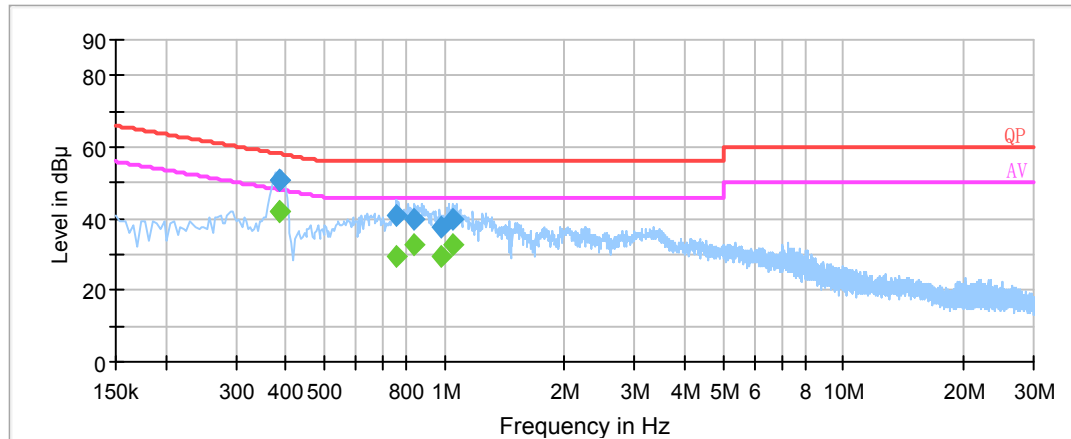
EMI Auto Test L



Frequency (MHz)	Corrected Amplitude (dBμV)	Correction Factor (dB)	Limit (dBμV)	Margin (dB)	Detector (PK/Ave./QP)
0.380330	45.8	20.2	58.3	12.5	QP
0.384150	44.5	20.2	58.2	13.7	QP
0.734990	34.8	20.0	56.0	21.2	QP
0.754630	38.5	20.0	56.0	17.5	QP
0.995090	35.3	20.1	56.0	20.7	QP
1.038310	35.5	20.1	56.0	20.5	QP
0.380330	35.3	20.2	48.3	13.0	Ave.
0.384150	34.1	20.2	48.2	14.1	Ave.
0.734990	25.1	20.0	46.0	20.9	Ave.
0.754630	27.1	20.0	46.0	18.9	Ave.
0.995090	28.9	20.1	46.0	17.1	Ave.
1.038310	28.4	20.1	46.0	17.6	Ave.

**AC 120V/60 Hz, Neutral**

EMI Auto Test N



Frequency (MHz)	Corrected Amplitude (dBμV)	Correction Factor (dB)	Limit (dBμV)	Margin (dB)	Detector (PK/Ave./QP)
0.384150	50.5	20.2	58.2	7.7	QP
0.384210	50.5	20.2	58.2	7.7	QP
0.758630	40.8	20.0	56.0	15.2	QP
0.841370	39.7	20.0	56.0	16.4	QP
0.979390	37.4	20.1	56.0	18.6	QP
1.054310	39.8	20.1	56.0	16.2	QP
0.384150	42.1	20.2	48.2	6.1	Ave.
0.384210	42.2	20.2	48.2	6.0	Ave.
0.758630	29.5	20.0	46.0	16.5	Ave.
0.841370	32.5	20.0	46.0	13.5	Ave.
0.979390	29.4	20.1	46.0	16.6	Ave.
1.054310	32.6	20.1	46.0	13.4	Ave.

**Note:**

- 1) Correction Factor = LISN VDF (Voltage Division Factor) + Cable Loss + Transient Limiter Attenuation
- 2) Corrected Amplitude = Reading + Correction Factor
- 3) Margin = Limit – Corrected Amplitude

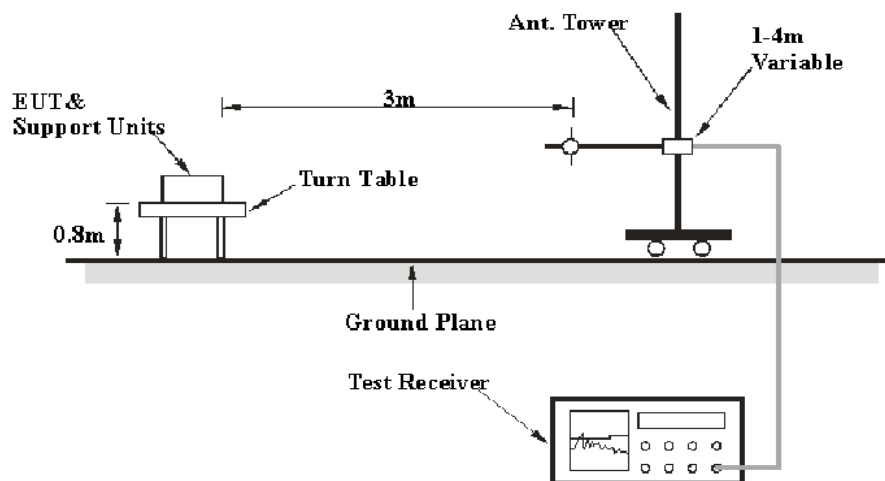


**FCC §15.209, §15.205 & §15.247(d) - SPURIOUS EMISSIONS****Applicable Standard**

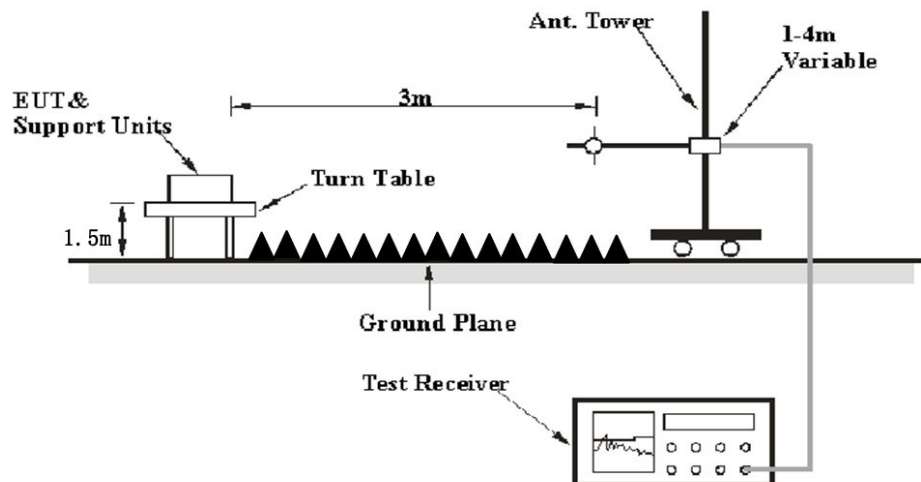
FCC §15.247 (d); §15.209; §15.205;

**EUT Setup**

**Below 1 GHz:**



**Above 1GHz:**



The radiated emission tests were performed in the 3 meters test site, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209, and FCC 15.247 limits.

## EMI Test Receiver & Spectrum Analyzer Setup

The system was investigated from 30 MHz to 25 GHz.

During the radiated emission test, the EMI test receiver & Spectrum Analyzer Setup were set with the following configurations:

Frequency Range	RBW	Video B/W	IF B/W	Measurements
30 MHz – 1000 MHz	100 kHz	300 kHz	120 kHz	QP
Above 1 GHz	1MHz	3 MHz	/	PK
	1MHz	10 Hz <sup>Note 1</sup>	/	Ave.
	1MHz	> 1/T <sup>Note 2</sup>	/	Ave.

Note 1: when duty cycle is no less than 98%

Note 2: when duty cycle is less than 98%

## Test Procedure

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

Data was recorded in Quasi-peak detection mode for frequency range of 30 MHz-1 GHz, peak and Average detection modes for frequencies above 1 GHz.

## Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and Cable Loss, and subtracting the Amplifier Gain from the Meter Reading. The basic equation is as follows:

$$\text{Corrected Amplitude} = \text{Meter Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Amplifier Gain}$$

The “**Margin**” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of 7dB means the emission is 7dB below the limit. The equation for margin calculation is as follows:

$$\text{Margin} = \text{Limit} - \text{Corrected Amplitude}$$

## Test Results Summary

According to the recorded data in following table, the EUT complied with the FCC Title 47, Part 15, Subpart C, section 15.205, 15.209 and 15.247.

Refer to CISPR16-4-2:2011 and CISPR 16-4-1:2009, the measured level complies with the limit if

$$L_m + U_{(L_m)} \leq L_{\text{lim}} + U_{\text{cispr}}$$

In BACL,  $U_{(L_m)}$  is less than  $U_{\text{cispr}}$ , if  $L_m$  is less than  $L_{\text{lim}}$ , it implies that the EUT complies with the limit.

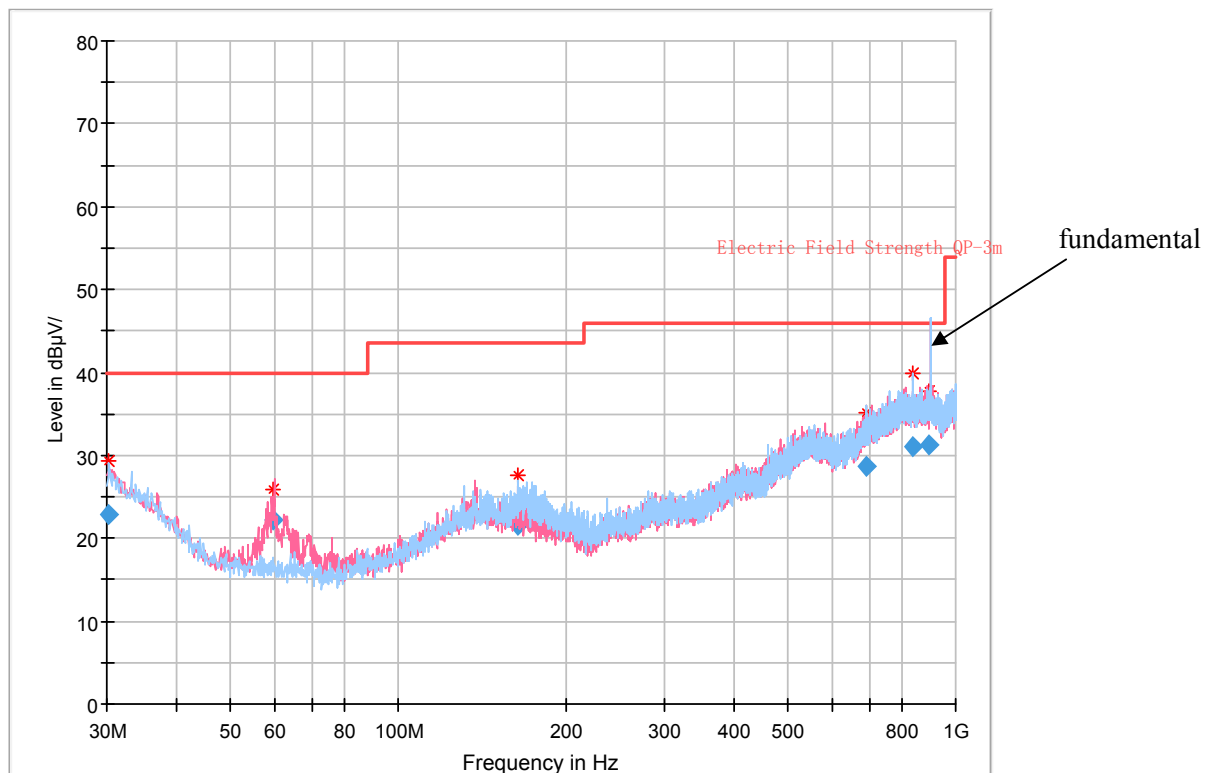
**Test Data****Environmental Conditions**

<b>Temperature:</b>	22 °C
<b>Relative Humidity:</b>	48 %
<b>ATM Pressure:</b>	101.0 kPa

The testing was performed by Kobe Li on 2017-08-16.

EUT operation mode: Transmitting

**30 MHz~1 GHz: (worst case was BLE and LoRa 500kHz mode transmitting simultaneously)**



Frequency (MHz)	Corrected Amplitude (dBμV/m)	Antenna height (cm)	Antenna Polarity	Turntable position (degree)	Correction Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
30.158802	22.79	334.0	H	60.0	0.2	40.00	17.21
59.559625	22.27	104.0	V	166.0	-11.8	40.00	17.73
164.440625	21.57	225.0	H	301.0	-5.4	43.50	21.93
692.034750	28.76	253.0	H	355.0	6.3	46.00	17.24
836.578625	31.11	139.0	H	91.0	9.0	46.00	14.89
891.982250	31.18	164.0	V	279.0	9.6	46.00	14.82

**1 GHz-25 GHz:**

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	FCC Part 15.247/205/209	
	Reading (dBμV)	PK/QP/Ave.		Height (m)	Polar (H/V)			Limit (dBμV/m)	Margin (dB)
Low Channel (2402 MHz)									
2402.00	59.77	PK	160	2.0	H	33.92	93.69	/	/
2402.00	57.93	Ave.	160	2.0	H	33.92	91.85	/	/
2402.00	58.02	PK	214	1.3	V	33.92	91.94	/	/
2402.00	55.12	Ave.	214	1.3	V	33.92	89.04	/	/
2341.26	27.76	PK	239	1.0	H	33.83	61.59	74	12.41
2341.26	13.87	Ave.	239	1.0	H	33.83	47.70	54	6.30
2350.56	26.78	PK	17	2.0	H	33.92	60.70	74	13.30
2350.56	13.87	Ave.	17	2.0	H	33.92	47.79	54	6.21
2486.73	26.72	PK	179	2.0	H	34.08	60.80	74	13.20
2486.73	13.31	Ave.	179	2.0	H	34.08	47.39	54	6.61
4804.00	48.52	PK	264	2.4	H	5.84	54.36	74	19.64
4804.00	42.18	Ave.	264	2.4	H	5.84	48.02	54	5.98
Middle Channel (2442 MHz)									
2442.00	58.15	PK	140	1.5	H	33.92	92.07	/	/
2442.00	56.54	Ave.	140	1.5	H	33.92	90.46	/	/
2442.00	57.04	PK	161	2.4	V	33.92	90.96	/	/
2442.00	54.74	Ave.	161	2.4	V	33.92	88.66	/	/
2312.56	27.56	PK	57	1.1	H	33.83	61.39	74	12.61
2312.56	13.87	Ave.	57	1.1	H	33.83	47.70	54	6.30
2342.38	27.67	PK	118	2.2	H	33.83	61.50	74	12.50
2342.38	13.88	Ave.	118	2.2	H	33.83	47.71	54	6.29
2490.11	27.23	PK	255	1.4	H	34.08	61.31	74	12.69
2490.11	13.26	Ave.	255	1.4	H	34.08	47.34	54	6.66
4884.00	47.86	PK	5	1.8	H	6.21	54.07	74	19.93
4884.00	42.50	Ave.	5	1.8	H	6.21	48.71	54	5.29

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	FCC Part 15.247/205/209	
	Reading (dBμV)	PK/QP/Ave.		Height (m)	Polar (H/V)			Limit (dBμV/m)	Margin (dB)
High Channel (2480 MHz)									
2480.00	54.06	PK	113	1.2	H	34.08	88.14	/	/
2480.00	53.22	Ave.	113	1.2	H	34.08	87.30	/	/
2480.00	55.74	PK	142	1.1	V	34.08	89.82	/	/
2480.00	53.06	Ave.	142	1.1	V	34.08	87.14	/	/
2319.61	27.24	PK	91	2.2	V	33.83	61.07	74	12.93
2319.61	13.89	Ave.	91	2.2	V	33.83	47.72	54	6.28
2497.02	27.09	PK	285	2.2	V	34.08	61.17	74	12.83
2497.02	13.26	Ave.	285	2.2	V	34.08	47.34	54	6.66
2488.75	27.03	PK	280	2.3	V	34.08	61.11	74	12.89
2488.75	13.28	Ave.	280	2.3	V	34.08	47.36	54	6.64
4960.00	46.05	PK	64	1.5	V	7.82	53.87	74	20.13
4960.00	39.95	Ave.	64	1.5	V	7.82	47.77	54	6.23

**Note:**

Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor

Corrected Amplitude = Corrected Factor + Reading

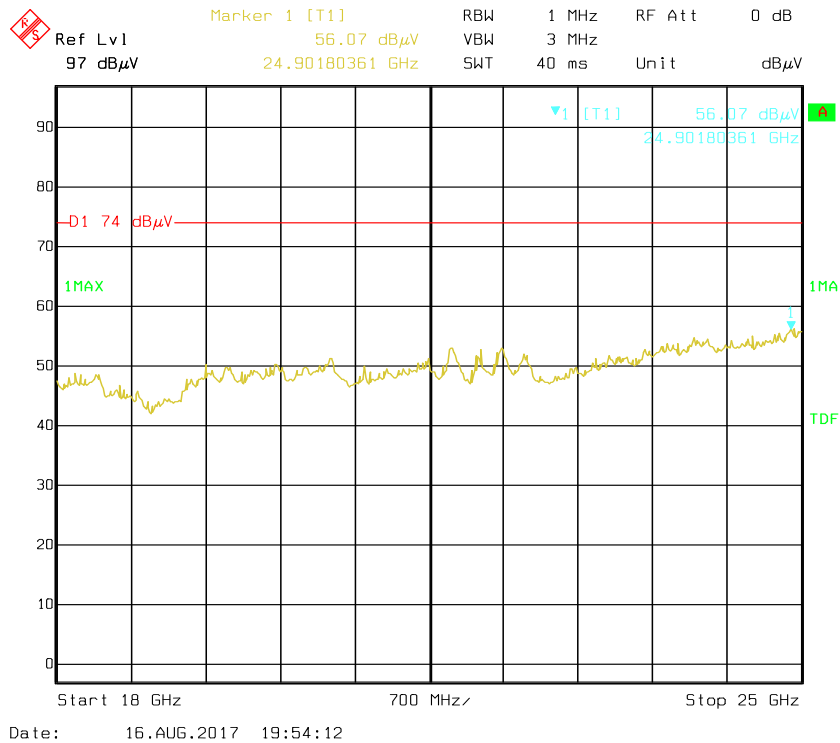
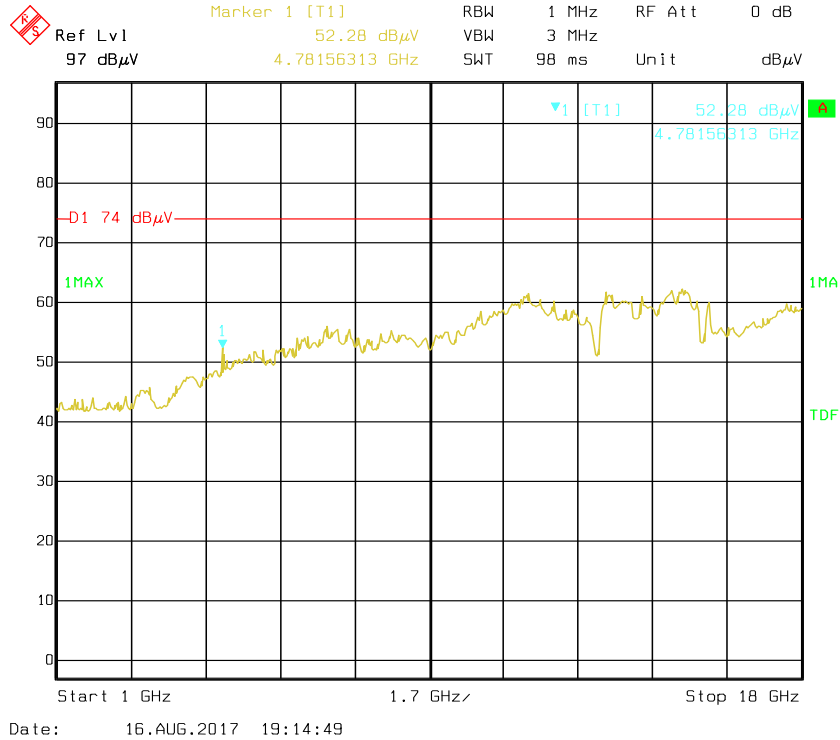
Margin = Limit - Corrected. Amplitude

The other spurious emission which is 20dB to the limit was not recorded.

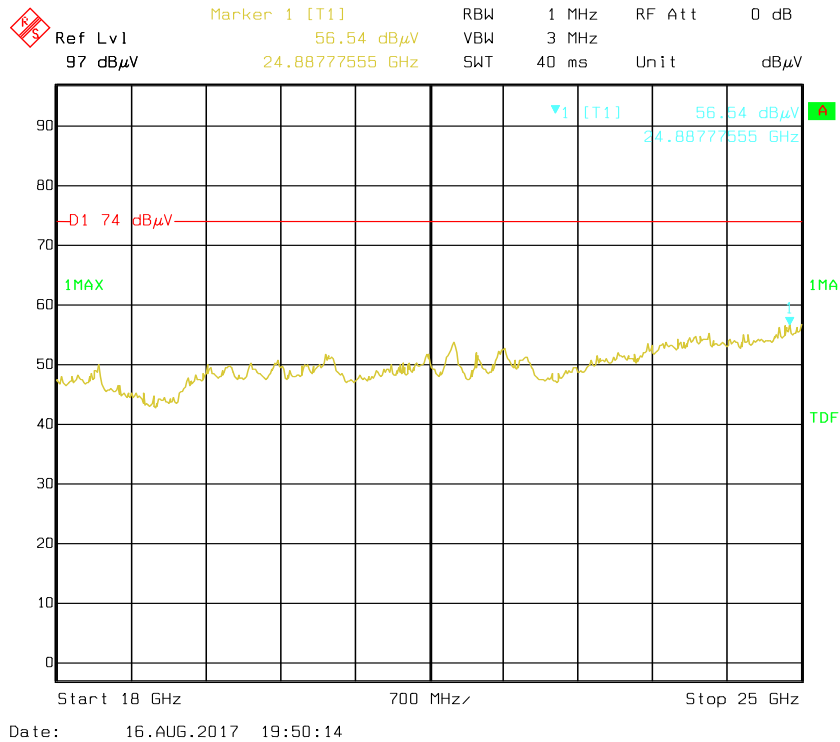
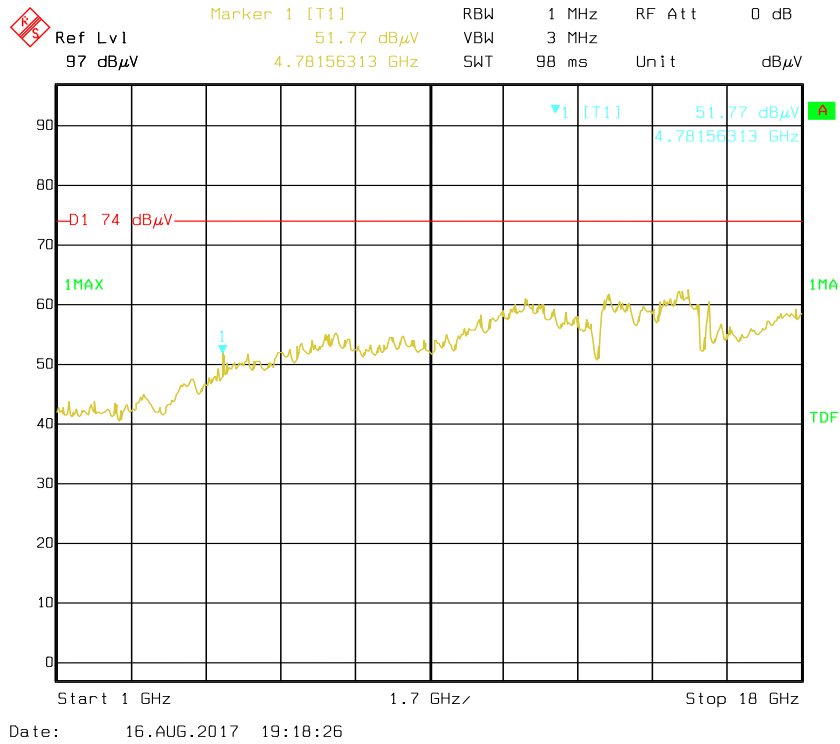
And for the pre-scan is performed with the 2400-2483.5MHz band filter.

# Pre-scan with Low channel

## Horizontal



# Vertical



For BLE and LoRa co-location transmitting simultaneously:

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	FCC Part 15.205/209	
	Reading (dBμV)	PK/QP/Ave.		Height (m)	Polar (H/V)			Limit (dBμV/m)	Margin (dB)
2391.45	43.23	PK	311	1.3	H	-6.46	36.77	74	37.23
2391.45	29.19	Ave.	311	1.3	H	-6.46	22.73	54	31.27
2391.45	42.61	PK	185	1.6	V	-6.46	36.15	74	37.85
2391.45	48.57	Ave.	185	1.6	V	-6.46	42.11	54	11.89



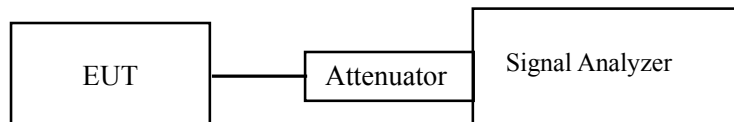
## FCC §15.247(a) (2) – 6 dB EMISSION BANDWIDTH

### Applicable Standard

Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

### Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
3. Measure the frequency difference of two frequencies that were attenuated 6 dB from the reference level. Record the frequency difference as the emission bandwidth.
4. Repeat above procedures until all frequencies measured were complete.



### Test Data

#### Environmental Conditions

Temperature:	24 °C
Relative Humidity:	53 %
ATM Pressure:	101.0 kPa

*The testing was performed by Kobe Li on 2017-07-21.*

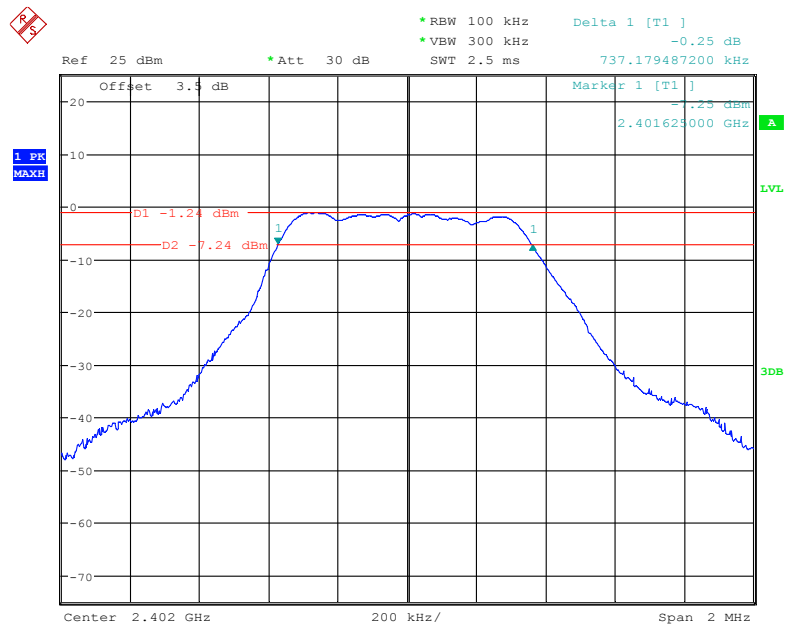
**Test Result:** Pass.

Please refer to the following table and plots.

*EUT operation mode: Transmitting*

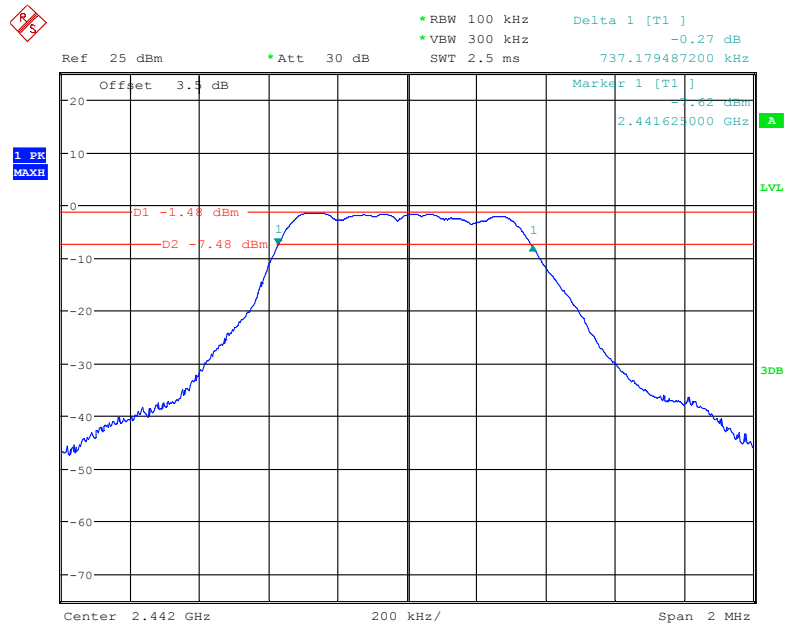
Channel	Frequency (MHz)	6 dB Emission Bandwidth(MHz)	Limit (kHz)
BLE mode			
Low	2402	0.737	≥500
Middle	2442	0.737	≥500
High	2480	0.696	≥500

### BLE Low Channel



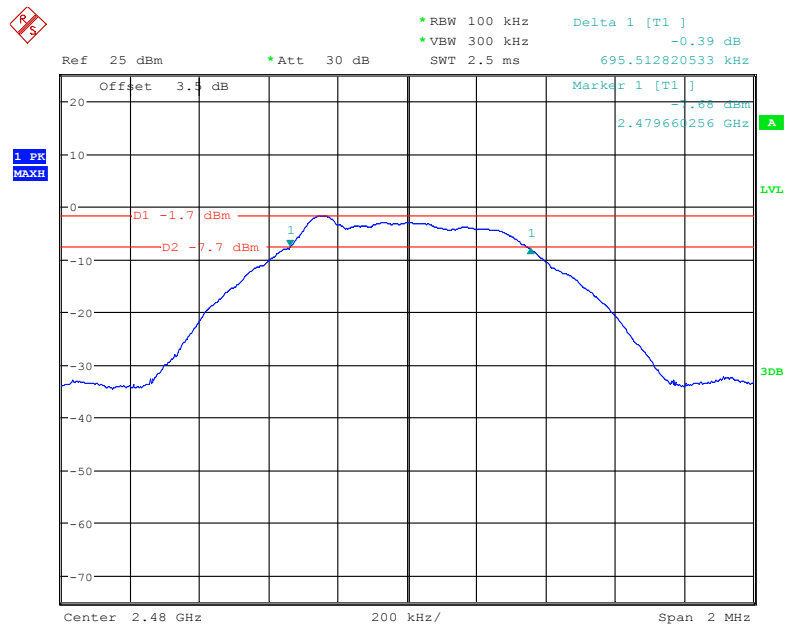
Date: 21.JUL.2017 09:56:44

### BLE Middle Channel



Date: 21.JUL.2017 09:58:42

### BLE High Channel



Date: 21.JUL.2017 10:00:57

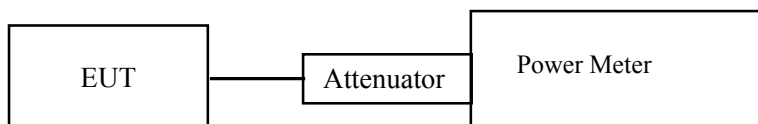
## FCC §15.247(b) (3) - MAXIMUM CONDUCTED OUTPUT POWER

### Applicable Standard

According to FCC §15.247(b) (3), for systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

### Test Procedure

1. Place the EUT on a bench and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to one test equipment.
3. Add a correction factor to the display.



### Test Data

#### Environmental Conditions

Temperature:	24 °C
Relative Humidity:	53 %
ATM Pressure:	101.0 kPa

The testing was performed by Kobe Li on 2017-07-21.

EUT operation mode: Transmitting

#### BLE mode

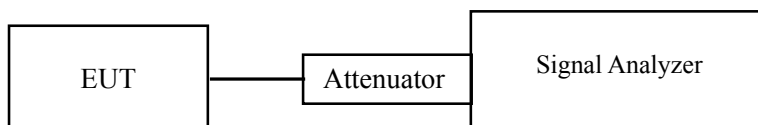
Channel	Frequency (MHz)	Max Peak Output Power (dBm)	Limit (dBm)	Result
Low	2402	-0.99	30	Pass
Middle	2442	-1.22	30	Pass
High	2480	-1.58	30	Pass

**FCC §15.247(d) – 100 kHz BANDWIDTH OF FREQUENCY BAND EDGE****Applicable Standard**

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

**Test Procedure**

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW to 100 kHz and VBW of spectrum analyzer to 300 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.

**Test Data****Environmental Conditions**

Temperature:	24 °C
Relative Humidity:	53 %
ATM Pressure:	101.0 kPa

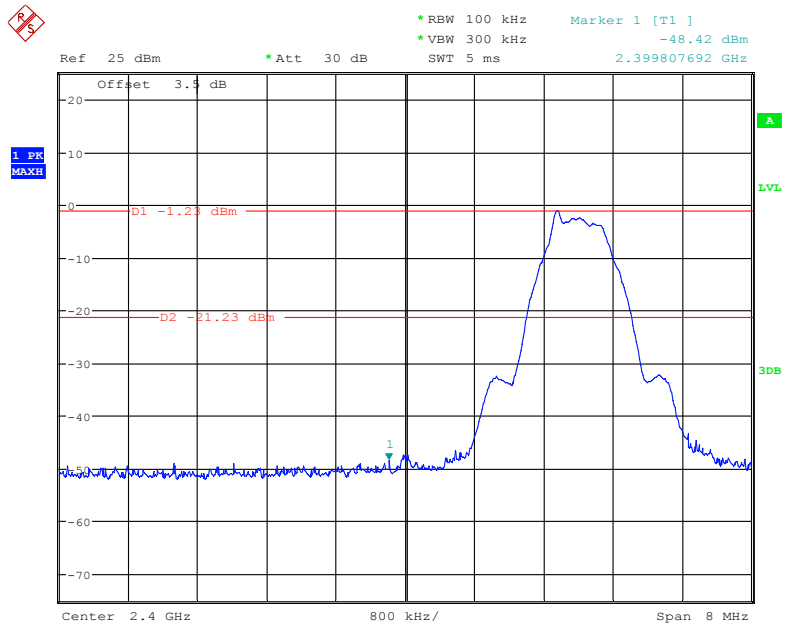
*The testing was performed by Kobe Li on 2017-07-21.*

*EUT operation mode: Transmitting*

**Test Result:** Compliance

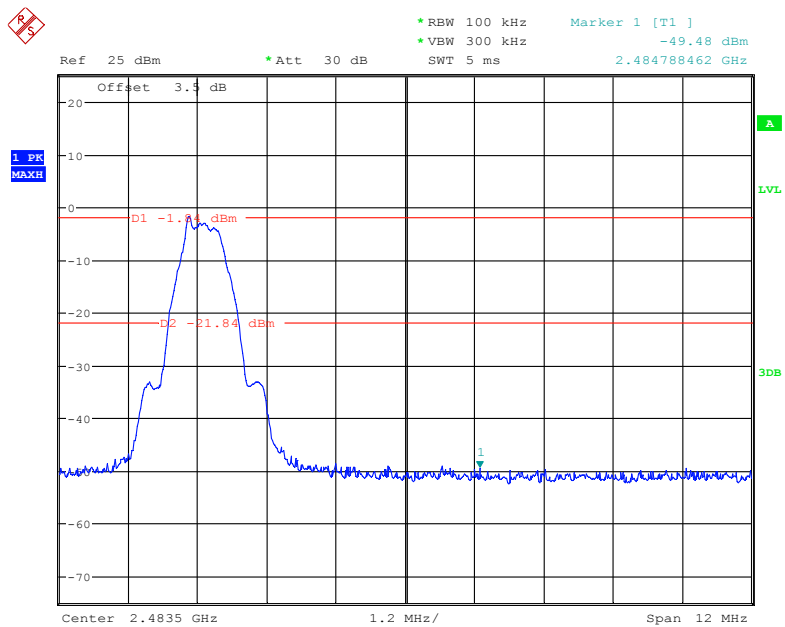
Please refer to the following plots.

### BLE: Band Edge, Left Side



Date: 21.JUL.2017 10:16:21

### BLE: Band Edge, Right Side



Date: 21.JUL.2017 10:03:52

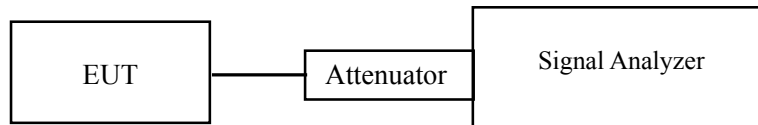
## FCC §15.247(e) - POWER SPECTRAL DENSITY

### Applicable Standard

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

### Test Procedure

1. Use this procedure when the maximum peak conducted output power in the fundamental emission is used to demonstrate compliance.
2. Set the RBW to:  $3\text{ kHz} \leq \text{RBW} \leq 100\text{ kHz}$ .
3. Set the VBW  $\geq 3 \times \text{RBW}$ .
4. Set the span to 1.5 times the DTS bandwidth.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.



### Test Data

#### Environmental Conditions

Temperature:	24 °C
Relative Humidity:	53 %
ATM Pressure:	101.0 kPa

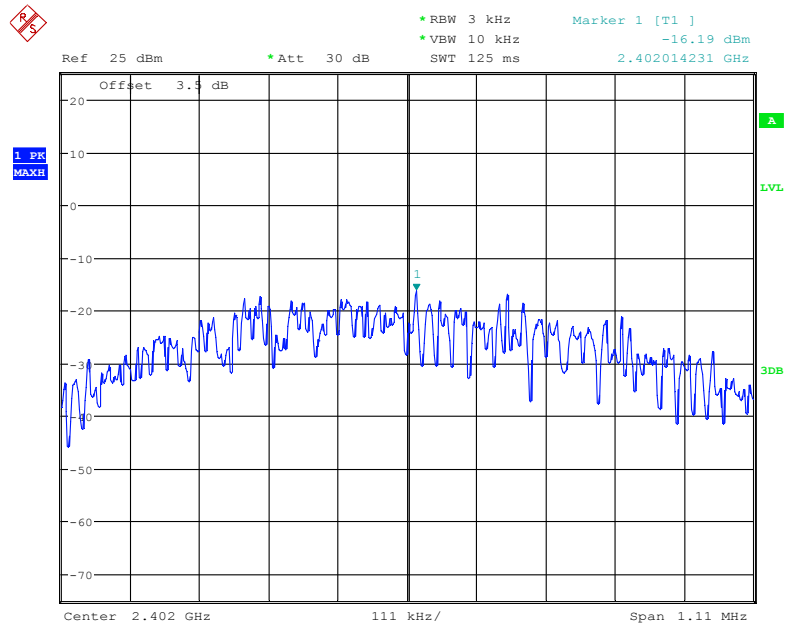
The testing was performed by Kobe Li on 2017-07-21.

EUT operation mode: Transmitting

Test Result: Pass

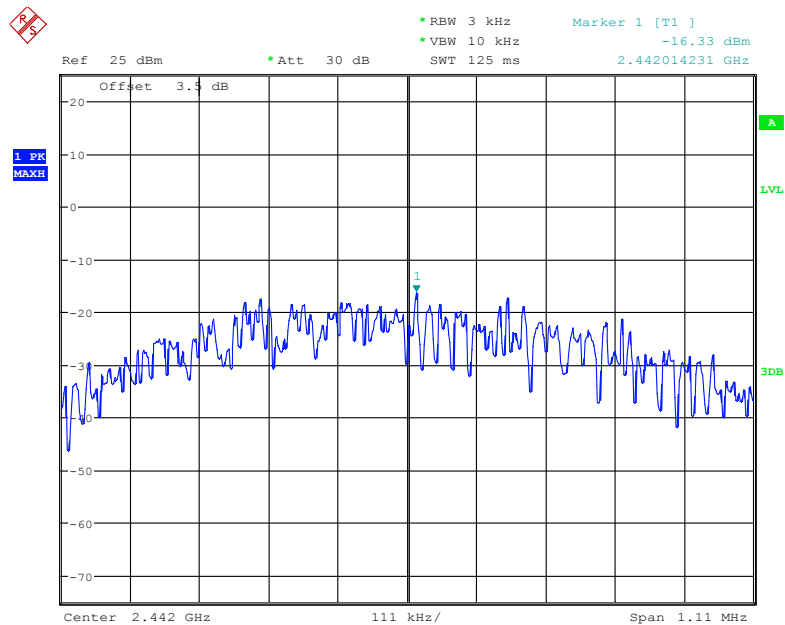
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)
BLE mode			
Low	2402	-16.19	$\leq 8$
Middle	2442	-16.33	$\leq 8$
High	2480	-16.67	$\leq 8$

### Power Spectral Density, BLE Low Channel



Date: 21.JUL.2017 10:18:43

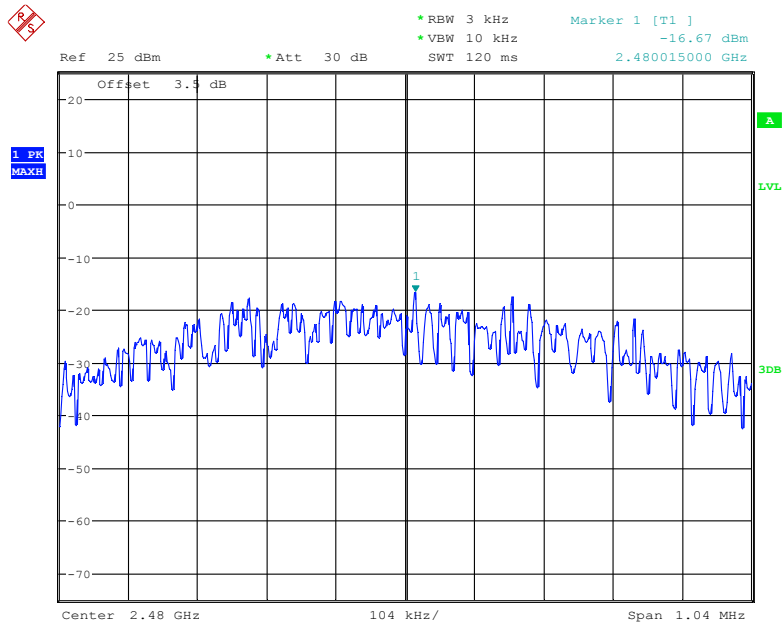
### Power Spectral Density, BLE Middle Channel



Date: 21.JUL.2017 10:10:56



Power Spectral Density, BLE High Channel



Date: 21.JUL.2017 10:08:19

\*\*\*\*\* END OF REPORT \*\*\*\*\*